The National Map

Comprehensive Urban Ecosystem Study: Landscape Dynamics Along the Colorado Front Range

The U.S. Geological Survey's Geography Discipline is leading the development and application of the Comprehensive Urban Ecosystem Study (CUES). This initiative, a component of *The National Map*, is an integrated venture of Geography's Geographic Analysis and Monitoring, Land Remote Sensing and Cooperative Topographic Mapping Programs, and other USGS, Department of the Interior, federal, state and local partners.

This initiative will focus resources on the integrated assessment and monitoring of seven critical urban ecosystems to support the development of digital map products, analytical tools and decision support systems to address important geographic issues facing the Nation.

The seven target urban ecosystems are:

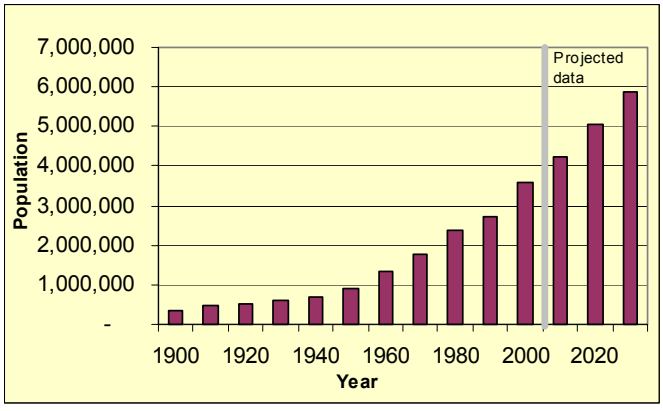
Washington, DC
Charleston, SC
Colorado Front Range
Sacramento, CA
Tampa/Saint Petersburg
Tahoe/Reno CA-NV
St. Louis, MO

These sites were selected because they afford a complementary set of landscape laboratories that allow USGS and partner scientists and researchers to develop and test a full suite of critical landscape challenges.

Background

The study of Landscape Dynamics Along the Colorado Front Range (subsequently called the Colorado CUES) will collect, integrate and make available geospatial data and scientific understanding produced by the Geography Discipline to address numerous resource use, sustainability and ecosystem health issues which pertain to the urban ecosystem environment. The project will demonstrate the depth of analysis and discovery possible when a robust, multi-scale geographic database is made available. Further, it will provide an assessment of what is needed to aid in the development of *The National Map*. The project will coordinate efforts in USGS Geography Discipline programs: Geographic Analysis and Monitoring (GAM), Land Remote Sensing (LRS), and Cooperative Topographic Mapping (CTM) Programs to access the scientific knowledge and spatial data of the Geography Discipline through The National Map.

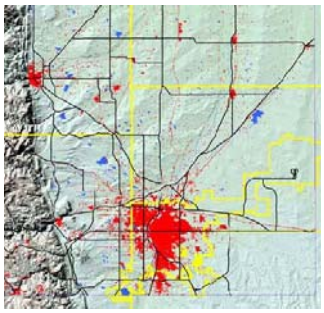
The Colorado CUES will address landscape change and its effects on specific resources. The population of the Colorado Front Range has increased from 330,000 in 1900 to over 3.5 million in 2000 and is projected to grow to a population of 5.8 million by 2030.



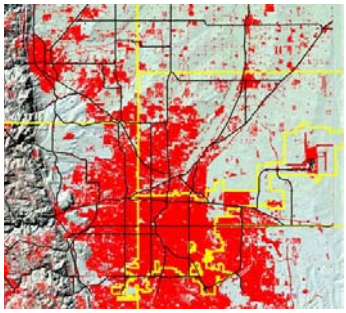
Front Range MSA Population Growth

This population growth has resulted in significant transformations in the Colorado

landscape. The consequences of human induced landscape change include increased demand for natural resources (air, water, minerals, plants, animals, open space), the creation of additional impervious surfaces (which generate increased urban runoff that contributes to increased flood risk and higher levels of nutrient loading in water bodies) the loss of wildlife habitat (including threatened and endangered species) increased air pollution, increased fire risk to human populations, and increased traffic congestion.



Denver-Boulder Urban Areas 1937

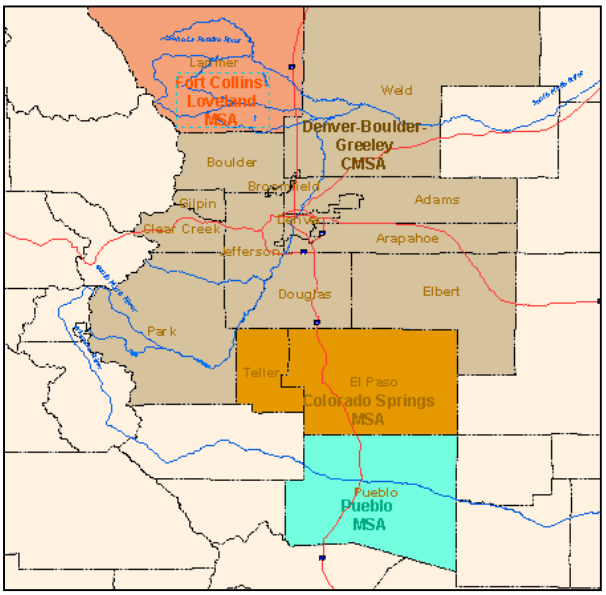


Denver-Boulder Urban Areas 2000

Objectives:
The Colorado CUES will map and analyze past landscape change in the study area, model possible future landscape change scenarios, collaborate with partner organizations on resource applications of landscape change analysis and modeling, and provide access to the body of scientific knowledge generated by this project over the Internet through The National Map.

The project area for the Colorado CUES will be the Front Range Metropolitan Statistical Areas (MSAs). The counties in these MSAs have experienced the most significant population growth in Colorado over the past century and are expected to continue this trend in the future. Other natural geographic boundaries, such as watersheds or ecoregions, can be used to help analyze the impacts of human-induced landscape change in the area.

Potential partners of landscape change modeling include Douglas County for local applications, the state of Colorado for regional applications and the USGS Biological Resources Discipline, in cooperation with the National Park Service and the Environmental Protection Agency, for federal and national applications. The local (county) application will be an analysis of open space acquisitions on wildlife habitat. The



Project boundary of Colorado CUES

regional (state) application will analyze the consequences of landscape change on fire hazard in the wildland urban interface, and the relationship between transportation development and landscape change. The federal application will study how landscape change affects air and water quality in high elevation federal lands east of the continental divide.

Methods:
To achieve the Colorado CUES objectives the Rocky Mountain Mapping Center (RMMC) will leverage on-going investigations. RMMC's land cover mapping teams shall be tasked to complete the land cover/land use layer and other geospatial data layers in the project area. Ongoing landscape change modeling of the Colorado Front Range will serve as a major catalyst for the CUES. RMMC's web mapping development team will have the goal to develop technical prototypes to store, update and serve new data sets. RMMC's partnership and data integration teams will be assigned the responsibility to fill gaps in data coverage, inventory, catalog and document new data sets. In addition, these data will be integrated into an applications ready environment.

Spatial Database Development: The Front Range Infrastructure Resources (FRIR) Project developed significant geographic data sets; these data sets are seamless and consistent across a portion of the CUES project area. However, Douglas County, the fastest growing county in the nation during the 1990's was not included in the FRIR. For this reason Douglas County will be completed first. Once Douglas County is finished other counties will be added to the project area; the order of completion will depend on the geographic applications required. Datasets that will be completed include the current and historical transportation and landcover/landuse, the hydrography (a component of the NHD- National Hydrography Database), elevation, and orthoimagery.

Urban Dynamics and Landscape Change Analyses: This project will demonstrate three geographic analyses of landscape change: 1) a pilot test of the standardized core and localized metrics (landscape metrics are factors that can be used to assess landscape change such as transportation), 2) an analysis of landscape change over the past 65 years, and 3) a predictive landscape change model for Douglas County and the Front Range MSAs. These applications will demonstrate the rates and patterns of urban growth of the Colorado Front Range area under various scenarios incorporating such constraining factors as urban growth boundaries, alternating transportation density levels, high fire risk or "red zones", and the impact of water restrictions as a result of the continuing drought in the region. *The National Map* base layers, the 133 Urban Areas Denver Pilot and Douglas County data will be used as a source for meeting these data needs. This activity will also establish an efficient method for accessing the required data and providing the geographic analysis and modeling tools for *The National Map*.

Delivery of geospatial information and modeling results via the web: the Dynamic Web Atlas and *The National Map* Viewer projects are focused on the efficient delivery of geospatial information via the web. Both of these activities address alternatives for accessing and manipulating geo-spatial information from distributed databases. In addition, *The National Map* Viewer project provides access to a comprehensive set of USGS base layers for the United States. These data, in combination with the data generated by the Denver 133 UA Pilot activity, and in cooperation with partners such as Douglas County will provide the geospatial framework for the study site.

The National Map portal will also allow users to interact with landscape change models and visualize landscape change through metrics such as the amount of developed lands, urban land migration, and transportation accessibility.

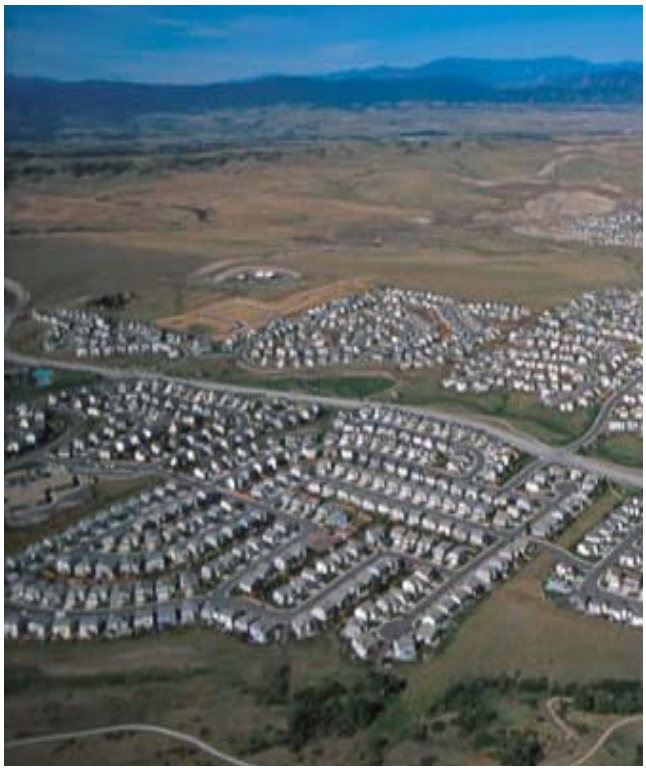


photo by John Fielder
Urban development in Douglas County

Timeline
Douglas County:

1) **Spatial database development:** April 2004
   a) Acquire, or create where necessary, hydrography, elevation and orthoimagery data
   b) Complete historical and contemporary landuse/landcover and transportation datasets
   c) Create metadata.

2) **Urban dynamics and landscape change analyses:** June 2004
   a) Completed landscape change analyses and predictive models for Douglas County
   b) Validate model results with historical data
3) **Delivery of spatial information via the web:** January 2004
   a) Online spatial database of Douglas County landuse and landcover and associated datasets available through *The National Map* Portal.
   b) Make the results of landscape change analysis available as spatial databases and through visualization in *The National Map* Portal.
   c) Online report that allows researchers to duplicate these analyses
   d) Links to related websites and online resources.

State and Federal Applications: To be determined based on applications chosen

Outcomes and Results

The Colorado CUES will demonstrate the utility of *The National Map* to address landscape change and its impact on the environment and society. The new geographic analyses and data collection techniques and acquisitions resulting from this project will not only benefit the Colorado Front Range, but can be used in other locations experiencing similar issues. The lessons learned during this project will also aid *The National Map* by addressing technical problems that are inevitable in a development project of this type.

The National Map is a framework for geographic knowledge needed by the Nation. It will provide public access to consistent, high quality, geospatial data and information from multiple partners to help inform decision making by resource managers and the public. *The National Map's* data and information are crucial to understanding the consequences of landscape change and are needed to support land use planning, natural hazards forecasting and mitigation, and natural resource conservation. Furthermore, insights into the causes and mechanisms that underlie current and past land surface changes are essential to predict and respond to future issues related to the land surface.

Mining, riparian, and urban landscapes in the Colorado Front Range

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